LETTERS TO THE EDITOR.

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The Permeability of Iron Alloys.

IN a paper in the last number of the *Proceedings* of the Royal Society, Prof. Barrett refers to the increased permeability conferred on iron by alloying it with aluminium, and suggests an explanation on the supposition that the aluminium would remove traces of oxygen from the iron.

Some seven years ago, in the course of a series of measurements on the magnetic properties of iron alloys, I found that aluminium, phosphorus and arsenic decreased the coercive force and hysteresis loss very considerably, whilst aluminium very largely increased the permeability—the others less so. Silicon produced little effect, but probably slightly improved the iron. On mentioning this to my colleague, Prof. Arnold, he at once pointed out that these elements are just those which increase the size of the crystals in iron. Annealing, which also improves permeability and lessens hysteresis, also increases the scale of the crystals. It is probable, therefore, that the increase of permeability due to these substances is a secondary effect due to the increased size of the iron crystals. A foreign substance might be expected to act deleteriously in two ways: (1) by occupying space better filled by iron, (2) by combining with iron and forming a less magnetic chemical compound. Phosphorus and silicon would act in both ways, aluminium in the first only, which might account for a larger difference between its indirect favourable action on the iron crystals and its direct deleterious action. It would be interesting if investigators in this direction would try to correlate their permeability measurements with the results of microscopical analysis as well as chemical. W. M. HICKS.

University College, Sheffield, April 10.

Reform in Mathematical Teaching.

SOME of Prof. Perry's followers seem to me to miss a point which he realises clearly—viz. that the key to the whole position is in the examination system.

(1) The strength of the present system is very great. An impending examination converts the teacher from an enemy of the idle and refractory pupil into an ally—to the comfort of all parties. The success of his pupils at examinations gives a teacher some return for his labour; otherwise he would have to comfort himself by hoping that Kipling's great lines, "Therefore praise we famous men," might some day in some degree apply to him. The realised hope would be worth ten thousand times the immediate return, but hope deferred is discounted at very heavy rates.

(2) The present system might be very much better. Examining work is often badly paid; in the main and in the long run, bad pay means bad work. Thring said that you might have one generation of martyrs, but the second would be cheats.

The band of fossil examiners, each with his fossil syllabus, does much more harm than Procrustes. A is clever, but he must not go beyond the syllabus; B is slow, but he must be bustled along and got through the course somehow.

The fate of anything new or fresh is pretty sure. There is a Cambridge yarn about some one who set his favourite question, "Define a differential coefficient," but instead of getting the expected three or four lines of cram, he got the substance of five or six pages of Harnack's new German book on the calculus. He rose to the occasion and promptly marked it 0.

(3) But written examinations have inherent and inevitable defects, clearly indicated by Dr. Lathom "Examinations considered as a means of selection." The old style of question, which was rather reproduced than parodied by the famous "Very small elephant whose weight may be neglected, and whose coefficient of friction was $\sqrt{7}-\sqrt{3}$," may be replaced by "The relation between the weight and length of tusk of an elephant being represented by the equation $W=Al^3+Bl+C$," and so on . . . but a system of written examinations based on the new model would in the end be like unto the first.

The following axioms are put forward in the hope that they may be condemned as truisms:—

(1) Examinations are not to be multiplied beyond necessity.

(2) No examination is entitled to any confidence in which teachers or persons in close touch with the teachers have no part.

(3) *Viva voce* examinations are essential if weight is to be attached to the results of a single examination.

It would be most interesting if Prof. Perry, who has influence and persuasiveness, could arrange an experiment.

Get answers to a paper from a dozen candidates, good and bad mixed, have facsimile copies made, and submit them to twenty or so competent examiners. The discrepancies in the marks would, I think, be surprising.

If the examiners adopt the received plan of cutting each question into several bits and giving marks for each little bit, they will get results more concordant and more entirely out of relation to common sense or real life. C. S. JACKSON.

Woolwich.

THERE are two places in Prof. Perry's letter appearing in your issue of March 27 in which he mentions schoolmasters in terms of, in the one case praise, in the other blame. The first passage is where he congratulates the "reformers" "on having with them the good wishes of every thoughtful teacher of the whole country," but in the last passage he expresses the conviction that we shall "not very long remain in the foremost files of our time if we depend upon the schoolmasters." I hope that teachers are good for more than mere good wishes, and I think Prof. Perry will find that the reform he laments as scarcely within sight has not only begun, but is actually bearing fruit in the place in which, though the subject of controversy, the noise of the conflict is heard least—the schoolroom. Schoolmasters, like others, move with the times, and the "conventional schoolmaster" is a much rarer bird than the conventional examiner or the conventional inspector. I suppose syllabuses and text-books are a necessity still, but the competent teacher of mathematics needs not to be bound by anything of the kind. Personally, I see no necessity for this ideal text-book one hears about which is to replace Euclid, and those who caricature him; we are better without a text-book at all. Let a master be engaged capable of making his own syllabus for his own pupils, and give him a free hand to introduce modern geometry, differential calculus, &c., as he sees fit; such a man will welcome the appreciation of a competent inspector, himself a mathematician and, beyond that, a successful teacher of mathematics. As I have already hinted, reform in the schoolroom proceeds as rapidly as examiners will allow, rather more so in fact, for I know that many boys learn much that no examination they have been in for, or are likely to take, tests. My own work is in such a small way that I do not care much to bring it forward, but I must confess to periods of guilty satisfaction when I have robbed time from examination teaching and introduced boys, much to their interest, and I feel sure profit, to such things as coaxal circles, theory of inversion, cross ratios, and fundamentals of the integral calculus. Let the mouse help the lion!

I feel sure Prof. Perry and his fellow reformers—if they will find out what is being done on the spot by the teachers, or if the latter have as yet shrunk from any sort of attempt at reform, what their wishes and opinions are—will find convention at least as hateful to the teachers as to themselves. Of course, I am not speaking, as I am not qualified to speak, on behalf of those who form what I may term the "aristocracy" of the teaching profession; I myself and my teaching friends are mostly engaged in the small schools, large in number, situated in industrial districts, where the endowed school fights for an existence with the "technical" or even the higher-grade Board School, where boys leave between fourteen and sixteen, at the latter of which ages they are supposed to have the groundwork on which a knowledge of engineering can be built up. Yet to these Euclid must be taught. Of course, as a matter of fact, Euclid is not taught to them; they pass examinations in a subject that goes by that name, the satisfaction I personally have felt being in the reports of examiners, who, intending to reprove, have written, "the constructions and principles of proof were well known, but the wording of Euclid was not adhered to, and some points in the proofs were omitted. The riders were well done." In these schools, "practical plane and solid geometry" is a subject taught throughout; and there is many a germ which only requires a little encouragement to bear great fruit. I think that the power behind the reformers

may be even more potent than it is reckoned. With associations growing in influence, and the great facilities afforded for exchange of ideas, the body of teachers is very rapidly increasing in strength, and this reform in the teaching of mathematics, together with many another much-needed reform, is perhaps much more in the immediate future than is thought. At any rate, if the bow and arrow is still the official weapon, the use of the magazine rifle is being secretly taught, and we school teachers look forward with no misgivings to that great fight. Prof. Perry sees ahead for our people, rather we are "spoiling for it," for with it will come our freedom!

FRANK L. WARD.

1 Macdonald Place, Hartlepool, March 29.

Rearrangement of Euclid Book I., Pt. i.

IN answer to Prof. Lodge's letter I should like to say that we have for some time followed much the order he suggests. Euclid's order unnaturally separates propositions which should come together, *e.g.* I. 4, 8, 26, and is, therefore, a serious hindrance to a clear grasp of the subject-matter as distinct from mere exercise in logic.

The following order—substantially that suggested by Prof. Lodge—seems natural, and we have certainly found it work very well in practice.

(1) The propositions on angles, viz. 13, 14, 15, 27, 29, 32, cor. 2, 32. At this stage logical deduction from definitions and axioms is difficult and, to a boy, unconvincing. The following proof of I. 32 cor. 2 is convincing, at least: "If a man walks right round a rectilineal figure (starting and ending at a point in the middle of a side), he turns once round. Hence the exterior angles, which are the angles through which he turns, are together equal to 4 right angles." Similar proofs of 27 and 29 are equally convincing. Any attempt to analyse these proofs into the axioms on which they depend seems to me at this stage foolish; it is work for a highly trained and speculative mind, not for a boy.

(2) Triangulation, I. 4, 8, 26.

These are, I think, best presented as the outcome of experience passing into intuition, and as special cases of the general fact that three data are necessary and sometimes sufficient to determine a triangle. The special case of right-angled triangles with hypotenuse and one side given should be added and proved deductively from I. 5.

The rest of Book I. consists of exercises on these fundamental propositions:—Properties of a single triangle, I. 20, 5, 18, 6, 19; loci; quadrilaterals; areas. The order in which these last three subjects are taken is immaterial.

A special advantage of this arrangement is that it makes it easy to combine practical with theoretical work. It was, indeed, from the attempt to do this that we were led to follow this order, but even in purely theoretical work it has proved a great gain.

As to the omission of "constructions" from the deductive course, we agree—they are properly treated as exercises.

As to the effect of this change on real progress we have no doubt. As to examinations, we hope that they will before long (1) permit freedom in the order of propositions, (2) diminish bookwork and insist upon riders and practical work, as some, indeed, already do.

It seems illogical, but even in deserting Euclid's order we adhere to his numbers. The constant reference to cardinal propositions is a great help to thoroughness and clearness of knowledge, as well as to ease of questioning and answering. Probably no one will ever succeed in fixing fresh labels on to the propositions, and for the present at least we find the old ones useful, though they are to our boys quite arbitrary.

W. C. FLETCHER.

Liverpool Institute.

I QUITE agree with Prof. Alfred Lodge as to the order of propositions he proposes, which is practically the order I adopted in my "Foundations of Geometry." But he does not in his letter refer to what seems to me the chief reason for it, which is that the elementary geometry of straight lines and angles should precede the geometry of plane surfaces, including any propositions about areas. And to carry out this idea, the fundamental propositions which Euclid gives so badly in his XIth. book (props. 1–9) ought to be taken before such propositions as his I. 35 and 36. On the other hand, there are important propositions in the XIth. book, notably prop. 10 (if this is not included in the definition of parallelism) and props. 20 and 21, which come properly in what Prof. Lodge calls the first part of Book I.

By the way, I may mention that it seems to me illogical to prove I. 27, as Prof. Lodge does, by a simple "which is impossible," and to refer I. 29 to "Playfair's axiom." Neither proposition is nearer *a priori* truth than the other, and it is just as easy to disguise the difficulty, if you wish to do so, in either case.

EDWARD T. DIXON.

Racketts, Hythe, Hants, April 14.

WE have had the following arrangement of Euc., 1–32, in use for three years with more than two hundred pupils. 13, 14 (from the definitions); 15; 32, cor. 2, 32, 16, 17; 23, 8, 9; 4, 10. Locus of a point equidistant from two given points. 11, 12, 5; 26, 6. Locus of points equidistant from two intersecting straight lines.

This gives fourteen propositions; thirty-seven more complete all the plane geometry of Euc. I.–VI. and XII. required in mathematics or science. We have no superposition "proofs"; they merely obscure obvious truths. Parallels by superposition have been found beyond the capabilities of beginners. Why not alter the definition? At present it gives the least obvious property of parallels.

A caution to the professors who are teaching us how to teach. We are seeking a system of geometry suitable for boys of ten, and the most logical method is not necessarily the best; it is better to separate 4, 8, 26 by examples of their use and to leave the remaining case for trigonometry. Again, an ideal course must be inventional, and must grow out of practical work; therefore it must introduce problems as early as possible: a beginner should not be allowed to quote a construction which he cannot perform. Is not the demand for a purely theoretical course due to a desire to use 1, 9, in proving 1, 5, whilst retaining Euclid's proof of 1, 8?

T. PETCH.

Leyton Technical Institute, April 14.

IN reply to the appeal of Prof. Alfred Lodge for opinions with reference to his proposal to alter the sequence of Euclid's propositions by introducing those relating to parallels at the earliest possible stage, permit me to express what I hold to be insuperable objections to his proposed innovation.

Whatever other objections may be raised to Euclid's sequence of propositions, it at any rate has this distinguishing merit, that it separates the propositions (I. 1–28) which are independent of the postulate of parallels from those which are true only when that postulate is admitted. To obscure this distinction, as, for instance, by treating props. 16, 17 as corollaries of prop. 32 and so appearing to depend on the postulate of parallels, would to my mind, especially now that the non-Euclidean geometry of Lobatchewsky and others is an established part of mathematical science, be a distinctly retrograde step.

Further, this innovation is not in the least necessary to secure Prof. Lodge's object (with which I entirely sympathise), namely, a better and more natural grouping of the propositions about triangles.

For this purpose all that is necessary is to add I. 16 to the three (13, 14, 15) with which he proposes to begin. This proposition may at once be proved as follows:—

The triangle being A B C, the side B C produced to D and E the mid-point of A C, turn the triangle A E B about E until E A comes on E C and A on C, then E B comes to a position E F in the same straight line as B E, and since B E F, B C D meet in B. they cannot meet again, so that F lies on the same side of B D as A [N.B., here comes in the difference between plane and spherical surface geometry], and E C F or the angle A is less than the exterior angle A C D.

This proved and I. 17 as its corollary, the propositions about a single triangle and those about the comparison of triangles easily fall into a simple and natural sequence and grouping.

Shanklin, April 12.

ROBT. B. HAYWARD.

Winter Phenomena in Lakeland.

THERE being no record within my knowledge as to whether holly and ivy are starch-trees or fat-trees, *i.e.* as to whether their wood-starch disappears or otherwise in winter, a strict watch was set upon the phenomena. During the months of December, January and February, sections were taken at